AMBIENT AIR QUALITY IN THE SARNIA AREA

Annual Report 1979

Ministry of the Environment
Ontario

AMBIENT AIR QUALITY
IN THE
SARNIA AREA

ANNUAL REPORT 1979

Technical Support Section
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SUMMARY

Ambient air quality determined for 1979 in the Sarnia area through the monitoring network of the Ontario Ministry of the Environment displayed variable results. Levels of sulphur dioxide remained unsatisfactory in the downtown core of Sarnia. In Corunna, excursions above the 1-hour and 24-hour criteria for desirable ambient air quality with respect to sulphur dioxide were measured and on December 31, 1979, excursions primarily attributable to emissions in the United States were detected south of Courtright. Neither criterion was exceeded at the monitoring site in east Sarnia nor was the annual criterion exceeded at any monitoring station in the Sarnia area. A control strategy is being finalized in the form of a legal regulation to prevent excursions of the 24-hour criterion in downtown Sarnia as well as to reduce the frequency of excursions above the 1-hour criterion.

Suspended particulates were elevated in the downtown core of Sarnia during 1979. Major construction projects in the downtown core contributed appreciably to these elevated levels. For the most part, areas outside the downtown core experienced acceptable levels of suspended particulates.

Throughout Ontario elevated levels of photochemical oxidants in the form of ozone are experienced during the spring and summer months because of the long-range transport of ozone and chemicals that react to form ozone, combined with photochemical reactions between local emissions of chemicals that produce ozone. During 1979, 1.6 percent of the ozone measurements determined in the downtown core of Sarnia and 1.7 percent of the measurements determined at a rural site east of Petrolia exceeded the

criterion for desirable ambient air quality. The elevated levels of ozone primarily occur when there are southerly winds associated with weather systems favourable for photochemical reactions and the long range transport of pollutants. Adequate control of ozone will be dependent on the development of compatible control strategies at local and international levels.

Levels of carbon monoxide and nitrogen dioxide met the respective criteria for desirable ambient air quality during 1979. Levels of hydrogen sulphide and mercaptans were low, depicting satisfactory air quality.

Levels of fluorides, measured by fluoridation rate, were detected above the criteria for desirable ambient air quality in downtown Sarnia and south of Courtright. However, the criteria are based on the protection of vegetation and annual phytotoxicology surveys have not detected vegetation damage off company property.

INTRODUCTION

South of Sarnia there is a high density of industries and power plants on both sides of the St. Clair River. Emissions from the industries and power plants located in Ontario are regulated through a Certificate of Approval. To determine the effectiveness of the Certificate of Approval and related pollution control measures, ambient air quality monitors are operated by the Ministry of the Environment as well as by Ontario Hydro, the Lambton Industrial Society and private industry. The Ministry of the Environment also conducts phytotoxicology surveys to determine the effects of air pollutants on vegetation. In addition, the Ministry performs mathematical modelling on the dispersion of pollutants to evaluate levels of pollutants in areas where monitors are not located and to determine the best locations to site monitors.

This report presents the 1979 data for ambient air quality obtained through the monitoring network of the Ministry of the Environment and compares 1979 data to that of previous years.

DESCRIPTION OF MONITORING NETWORKS

Continuous and intermittent monitors for determining the levels of pollutants in ambient air are maintained by the Ministry at sites dispersed throughout the Sarnia area. Monitoring is most intensive in the area of downtown Sarnia because it is affected by emissions from industries and power plants to the south, as well as by dense vehicular traffic and commercial establishments in the downtown area. It is therefore believed that the downtown area is likely to experience higher levels of pollution than most other areas of the City.

During 1979 a van equipped with continuous monitoring instruments was used to measure levels of pollutants at two fixed sites in Corunna for several months. The locations of the van and the other fixed monitoring sites are illustrated in Figure 1, Appendix 1. Specific locations and pollutants monitored are listed in Table 1, Appendix 1.

Station 14051, a site in downtown Sarnia at which total suspended particulates are monitored by the Ministry, was relocated approximately 300 metres to the south to offset the effect of local construction activity. The station was renumbered 14151.

Criteria for desirable ambient air quality and the supporting rationale for the establishment of these criteria appear in Table 2, Appendix 1.

METEOROLOGICAL DATA

Meteorological data are utilized in predicting the stability of the atmosphere which affects the dispersion of pollutants. These data are also used to assist in identifying sources of elevated levels of pollutants and to validate mathematical models designed to simulate the dispersion of air pollutants.

At 10 metres, 30 metres and 92 metres above ground level, wind speed and direction are measured at station 14016, located immediately south of Courtright. In

addition, ambient air temperature is measured at the 10-metre level and the gradients in temperature between the 10-metre level and the 30- and 92-metre levels are determined. These meteorological data are telemetered to Toronto where meteorologists utilize them to forecast the stability of the atmosphere. This forecasting feature is an intrinsic part of the Air Pollution Index.

Wind speed and direction are also measured at the 10-metre level at station 14062, located in east Sarnia. In addition, the monitoring van which was utilized in Corunna during 1979 measured wind speed and direction at the 10-metre level.

Meteorological data from the 30-metre level at station 14016 have been used in computing the average concentrations of sulphur dioxide for specific wind directions, in order to correlate elevated levels of suspended particulates with wind direction, and to determine the number of hours that the criterion for ozone has been exceeded for different wind directions.

A summary of the frequency of winds for different directions at the 30-metre level at station 14016 appears in Table 3, Appendix 2. The data indicate that there was a higher-than-normal percentage of winds from the south during 1979, but typical wind frequencies for the south quadrant were experienced when southeasterly and southwesterly winds were taken into account.

PARTICULATES

Primary sources of man-caused emissions of particulates to the atmosphere are vehicular traffic, materials handling and combustion processes. Wind-blown particulates

from open fields, sand and coal piles, roadways and roofs are also significant sources.

Measurements for particulates are reported as total suspended particulates, dustfall and soiling index. Total suspended particulates are determined by drawing measured volumes of air through a pre-weighed filter for 24 hours and subsequently weighing the quantity of particulates collected on the filter. Dustfall is determined through the exposure of open cylinders (jars) of known diameter for approximately 30 days and subsequently weighing the amount of particulates collected. Soiling index is measured by determining the difference in the amount of light that is transmitted through a filter before and after ambient air is drawn through the filter for 1 hour. The amount of light transmitted through the filter is affected by the quantity, size, shape and opaqueness of particulates retained on the filter. Since soiling index can be correlated to levels of suspended particulates and can be determined without the time-consuming laboratory analysis required for the determination of concentrations of total suspended particulates, soiling index is used as a substitute for suspended particulate values when data are required quickly such as in the Air Pollution Index.

Suspended Particulates

Criteria for desirable ambient air quality with respect to suspended particulates are 120 micrograms of suspended particulates per cubic metre of air (ug/m^3) averaged over a 24-hour period, and 60 ug/m^3 as the annual geometric mean for 24-hour samples. The 24-hour criterion is based on impairment of visibility and adverse effects to health associated with combined concentrations of sulphur dioxide and suspended particulates. The annual criterion is based on public awareness to pollution and damage to property.

During 1979 total suspended particulates were sampled at 13 sites in the Sarnia area on a schedule of every sixth day. However, sampling at station 14051 was carried out only during January, after which time the station was relocated to the nearby site 14151. Data for the two sites are grouped together. Also, samples collected for several months by means of the instrumented monitoring van at station 14901 were collected immediately adjacent to station 14059; however, since data for station 14059 are representative of the complete year the particulate data for station 14901 are not reported. The monitoring van was used at station 14902 where total suspended particulate samples were collected in December of 1979 through April 1980. These data are not contained in this report. Data for the remaining 10 stations are summarized in Table 4 and Figure 2, Appendix 3.

The annual criterion was not met at 3 of the 10 stations for which data are listed in Table 4 and Figure 2. These same 3 stations, which are located in the downtown area of Sarnia, experienced the greatest frequencies of excursions above the 24-hour criterion. There were also 3 stations outside the downtown Sarnia area that experienced some excursions above the 24-hour criterion.

Station 14001 is located near the downtown core, but unlike the stations in the core area did not experience excursions above the criteria. The sampler at this station is located approximately 16 metres above ground level compared to the 3- and 4-metre levels for the downtown stations. Consequently the downtown stations would receive greater impact from low-level sources of particulates such as road dust and construction activities. It is unlikely that significant improvements in suspended particulates will be experienced in the downtown area until the major construction activities associated with the redevelopment of downtown Sarnia are complete.

To evaluate the trend in total suspended particulates the averages of the annual geometric means and the percentage of values above the 24-hour criterion for 5 sites in operation since 1972 were plotted as depicted in Figure 3, Appendix 3. It is apparent that appreciable reductions in levels of total suspended particulates occurred from 1972 to 1974 but no improvement is noticeable since 1975. Since the downtown core is the only area that tends not to continuously experience either satisfactory or desirable levels of suspended particulates, improvements in the general trend will probably be best achieved by better controls in the downtown core.

Correlations between levels of suspended particulates determined for samples collected from 10 sites operated throughout 1979 and data for wind speed and direction from the 30-metre level of station 14016, south of Courtright, were determined. The correlations are shown in Figure 4, Apppendix 3, with the length of the line corresponding to the various wind directions indicating the strength of the positive correlations. The positive correlations appear to be strongest with southerly and south-southwesterly winds. This may be attributable to many point sources of particulates being south to south-west of Sarnia. Also, southerly winds, which are associated with the backs of high pressure systems and the areas south of low pressure fronts, promote the long range transport of pollutants.

Chemical Analysis of Suspended Particulates

As part of a Province-wide study, samples of suspended particulates collected at 7 stations in Sarnia were analyzed for some or all of the following parameters: cadmium, chromium, copper, iron, lead, manganese, nickel, nitrate, sulphate and vanadium. A summary of the data for 1976 through 1979 is contained in Table 5, Appendix 3.

Criteria for desirable ambient air quality exist for cadmium, lead, nickel and vanadium. Concentrations of various metals have been low with no values above the criteria. There is no apparent trend of increasing levels of metals in suspended particulate matter. Average levels of nitrates and sulphates for 1979 are slightly greater than previous years.

Dustfall

The Ministry of the Environment's criteria for desirable ambient air quality with respect to dustfall are 7.0 grams of particulates per square metre per 30 days ($g/m^2/30$ days) in any single month and an annual average of 4.6 $g/m^2/30$ days. These criteria are based on historical data and criteria established by other enforcement agencies.

Dustfall is sampled at station 14049 and station 14151, located in the downtown core of Sarnia. Except for two monthly samples collected in the spring at station 14049 the samples collected at both stations in 1979 met the single-month criterion. Also, during 1979 the annual average criterion was met at station 14151 and exceeded at station 14049. Emissions from major construction activities and vehicular traffic in the downtown core are believed to account for much of the dustfall loading. Relocation of station 14051 to the present location at station 14151 which is further from the construction activity is at least partially responsible for the annual average dropping from 6.3 $g/m^2/30$ days in 1978 to 4.0 $g/m^2/30$ days in 1979. As well the influence of construction activity is reflected by an increase in 1978 from the 1977 level of 4.3 $g/m^2/30$ days. However when comparing dustfall levels for downtown Sarnia to those of other communities the comparison is generally favourable to Sarnia. Table 6, Appendix 3 contains the data for 1972 to 1979.

SULPHUR OXIDES

Combustion of sulphur-containing fuels such as coal and oil is the largest man-made source of sulphur dioxide emissions to the atmosphere. In the Sarnia area large quantities of these fuels are consumed by power-generating plants in Michigan and Ontario and by petroleum and petrochemical industries located south of downtown Sarnia.

Sulphur oxides are monitored in the Sarnia area by this Ministry as gaseous sulphur dioxide using continuous monitors and as sulphate in suspended particulates, as described in the previous section of this report.

SULPHUR DIOXIDE

During 1979 the Ministry of the Environment monitored gaseous sulphur dioxide continuously at 5 separate locations in the Sarnia area. At 2 additional sites in Corunna sulphur dioxide was monitored for separate periods of 3 and 8 months. There were 12 other sites where monitors providing continuous measurements of sulphur dioxide were operated by Ontario Hydro, the Lambton Industrial Society or private industry.

Data are reported as 1-hour average concentrations, 24-hour average concentrations (midnite to midnite) and annual average concentrations. Criteria for desirable ambient air quality are 0.25 parts of sulphur dioxide per million parts of air (ppm) during a 1-hour period, 0.10 ppm averaged for 24 hours and 0.02 ppm as an annual average. The criteria for the 1-hour and annual averages are based on the protection of vegetation while the 24-hour criterion is based on the protection of human health.

During 1979 the annual criterion was not exceeded. At station 14062, located in east Sarnia, neither the 1-hour nor the 24-hour criterion was exceeded. However, in the downtown core the 1-hour criterion was exceeded at station 14049 on 2 occasions or 0.01 percent of the measured values and at station 14064 on 5 occasions or 0.05 percent of the measured values. The 24-hour criterion was exceeded on 3 occasions at station 14049 and on 1 occasion at station 14064.

At stations 14004 and 14016, located south of Courtright in the vicinity of the Lambton Generating Station of Ontario Hydro and the St. Clair Generating Station of Detroit Edison, the 1-hour criterion was exceeded on 1 and 5 occasions, respectively. The 24-hour criterion was met continuously at station 14004 while at station 14016 it was exceeded on 1 occasion. The excursions above the 1-hour and 24-hour criteria at station 14016 were all associated with winds blowing from Michigan during the latter part of December 31, 1979. A review of data from other monitoring stations operated by the Ontario Hydro, the Lambton Industrial Society or this Ministry revealed elevated levels for sulphur dioxide during the same time period for those stations located south of Sarnia but north of the St. Clair Generating Station.

At station 14902, located in Corunna, sulphur dioxide was measured continuously for 55 days at the end of 1979. The 24-hour criterion was not exceeded while the 1-hour criterion was exceeded on 1 occasion, specifically during the episode of December 31, 1979 previously discussed.

Station 14901 was also located in Corunna and sulphur dioxide measurements were continuously made for 187 days. The 24-hour criterion was exceeded only on February 20, 1979, a day on which winds were southerly and south-

southwesterly. Excursions above the 24-hour criterion were also recorded on this date for the 2 Ministry stations in the downtown core of Sarnia. Although no excursions above the 1-hour criterion were reported for station 14901 on February 20, 1979, there were 5 hours when the criterion was exceeded. These 5 excursions occurred on 3 different days and were associated with southerly and southwesterly winds, indicating that sulphur dioxide sources between Corunna and Sarnia were not involved in these excursions.

A summary of data for sulphur dioxide levels determined during 1979 appears in Table 7, Appendix 4. Figure 5, Appendix 4 presents pollution roses for sulphur dioxide. The pollution roses were created using data for wind direction and speed from the 30-metre level of station 14016 and concentrations for sulphur dioxide determined at the various stations. The length of the line corresponding to a specific wind direction indicates the average sulphur dioxide concentration determined at the particular stations when winds were from that direction. The roses for stations 14049, 14062 and 14064 illustrate a strong influence of sources of sulphur dioxide south of downtown Sarnia. The rose for station 14016 reveals the influence of sources north of the monitoring site, as well as a slight influence from the south and south-southwest where the St. Clair Generating Station is located and from the south-southeast and southeast where the Lambton Generating Station is located. Station 14004 shows the influence of sources to the north and northwest. The rose for station 14901 illustrates a strong influence from the refinery and petrochemical industries to the north and from the power generating plants to the south.

Figure 6, Appendix 4 is presented to illustrate the trend in the frequencies of excursions above the 1-hour and 24-hour criteria for those stations operating at least 5

years. For station 14049 in downtown Sarnia there has been no reduction in the frequencies of excursions above the 24-hour criterion in recent years while the frequencies of excursions above the 1-hour criterion illustrate marginal improvement. At station 14016 the 24-hour criterion has not been exceeded except for the December 31, 1979 episode and excursions above the 1-hour criterion have also been infrequent. At station 14004 there has been a very significant reduction in the frequencies of excursions above both the 1-hour and 24-hour criterion which is attributable primarily to improvements in sulphur dioxide controls and dispersion at the St. Clair Generating Station.

Ontario is in the final stages of passing a regulation under The Environmental Protection Act pertaining to a control strategy for sulphur dioxide. The control strategy would have certain major emitters of sulphur dioxide in Lambton County provide additional controls or cut back emissions when elevated levels of sulphur dioxide are recorded and meteorological conditions conducive to elevated levels of sulphur dioxide are forecasted to persist. The elevated level of sulphur dioxide that will trigger the application of additional controls or cut-backs in emissions, will be lower than the 24-hour criterion for desirable ambient air quality to allow for a suitable period of time during which the controls may be brought into operation.

AIR POLLUTION INDEX

The Air Pollution Index (API) is a system designed to control or prevent an air pollution episode. Meteorological forecasting and current readings of sulphur dioxide and suspended particulates are utilized to predict the potential for the persistence of pollution conditions that are reported as the API.

Data for suspended particulates are provided by the measurement of soiling index and a correlation between concentrations of suspended particulates and soiling index. Hourly values of soiling index and gaseous sulphur dioxide are used to compute 24-hour running averages which are inserted into the following equation:

$$API = 0.18\ (31.15\ COH + 124.6\ SO_2)^{1.37}$$

Where: COH is soiling index expressed in units of coefficient of haze.
SO_2 is sulphur dioxide expressed in parts per million

API values below 32 are considered acceptable. Values from 32 to 49 are at the Advisory Level and if adverse weather conditions are likely to persist, those responsible for major emissions are advised to prepare to curtail operations. At an API of 50, major emitters may be ordered to curtail operations. At 75, further cutbacks can be required. If the API reaches 100 all industries and other contributors of pollution not essential to public health and safety may be ordered to cease operations.

Although the API is based on the control of combined levels of sulphur dioxide and suspended particulates, emissions of other pollutants may be controlled simultaneously. However, situations may occur where levels of certain pollutants such as ozone may be high and the API may be quite low. The normal monitoring program of the Ministry is used to detect these elevated levels of other pollutants.

Sulphur dioxide and soiling index data utilized to determine the API for Sarnia are obtained from monitors operated at station 14064 in the downtown core. During 1979 the API reached the Advisory Level for 25 hours with the

maximum level being 43. Of these 25 hours, 23 occurred on February 20 and 21, 1979 while the remaining 2 occurred in January. With the exception of these 25 hours, the API for Sarnia was in the acceptable range.

HYDROGEN SULPHIDE AND MERCAPTANS

Mercaptans are a group of organic compounds that contain sulphur and hydrogen and exhibit characteristics similar to hydrogen sulphide. Hydrogen sulphide is commonly referred to as rotten egg gas and many mercaptans are also malodorous at extremely low concentrations.

Both hydrogen sulphide and mercaptans originate in nature from anaerobic decomposition of organic matter containing sulphur. In the Sarnia area, the release of hydrogen sulphide and mercaptans into the atmosphere may results from the processing of petroleum feedstocks containing sulphur.

The criterion established to represent desirable ambient air quality with respect to hydrogen sulphide is 0.02 ppm as an average for 1 hour. This criterion is based on the offensive odours exhibited by this gas. Similarly, the criterion for mercaptans is based on odour and was established as 0.01 ppm averaged for 1 hour and expressed as methyl mercaptan.

Unfortunately, the monitoring instrument in Sarnia does not segregate hydrogen sulphide from mercaptans but determines their combined concentrations and reports these concentrations in terms of hydrogen sulphide. To adjust for this situation the combined concentrations of hydrogen sulphide and mercaptans are compared to the less restrictive criterion for hydrogen sulphide.

During 1979 the hourly criterion of 0.02 ppm was exceeded on 1 occasion at station 14062 located in east Sarnia. A summary of data is presented in Table 8, Appendix 5, for levels of hydrogen sulphide and mercaptans measured in downtown Sarnia at station 14049 from 1974 to 1978 and at station 14062 during 1979 and the last 3 months of 1978. The lower levels of hydrogen sulphide and mercaptans in recent years reflect the improvements in control of emissions.

CARBON MONOXIDE

Combustion processes represent man's major emissions of carbon monoxide. Emissions from motor vehicles are most significant because they occur near ground level and are concentrated in urban areas where the public may be exposed for lengthy periods. Industries and power-generating plants normally provide adequate dispersion for their emissions to prevent unsatisfactory levels of carbon monoxide in the ambient air.

The criteria for carbon monoxide, which are based on the protection of human health, are 30 ppm averaged for 1 hour and 13 ppm averaged for any consecutive 8-hour period.

During 1979 carbon monoxide was monitored at station 14064, located in the downtown core at Centennial Park. The criteria for desirable ambient air quality were not exceeded. Prior to July 1978, carbon monoxide was measured in downtown Sarnia at station 14049. A summary of data for carbon monoxide obtained since 1974 is presented in Table 8, Appendix 5, and illustrates long-term conformity below established criteria.

OXIDES OF NITROGEN

Oxides of nitrogen are emitted into the atmosphere by man through combustion processes. Nitric oxide and nitrogen dioxide are the compounds of primary interest.

Criteria for desirable ambient air quality exist for nitrogen dioxide, but not for nitric oxide or total oxides of nitrogen. The criteria, which are based on offensive odours and the protection of human health, are 0.20 ppm averaged for 1 hour and 0.10 ppm averaged for 24 hours. The criteria were not exceeded during 1979 at station 14064, located in the downtown core area, nor at station 14901 and 14902, sites in Corunna where oxides of nitrogen were measured for 33 days and 61 days, respectively.

A summary of data for oxides of nitrogen, presented in Table 8, Appendix 5, illustrates that levels of nitrogen dioxide are consistently below the established criteria. Levels of nitric oxide and total nitrogen oxides are in ranges typical for communities the size of Sarnia.

Oxides of nitrogen in combination with reactive hydrocarbons under certain meteorological conditions play an important role in the formation of unsatisfactory levels of photochemical oxidants. Therefore, consideration is being given to further controlling the levels of oxides of nitrogen.

HYDROCARBONS

Emissions from motor vehicles are a primary man-made source of hydrocarbons in the ambient air. Other significant man-made sources are incomplete combustion of

fuels by industries and power plants, and evaporation losses during the storage and transportation of hydrocarbons. Natural phenomena also produce many hydrocarbons of which methane is the most abundant.

Owing to the wide range of effects associated with different hydrocarbons at various concentrations, no criteria for desirable ambient air quality have been established for total hydrocarbons. Instead, control is achieved by setting criteria for desirable levels of specific hydrocarbons in ambient air and/or establishing standards which control the impact of emissions of specific hydrocarbons.

Values for total hydrocarbons determined during 1979 at station 14064 in the downtown core of Sarnia and at stations 14901 and 14902 in Corunna were comparable to levels monitored in other communities. At stations 14901 and 14902 monitoring was conducted for 200 days and 61 days, respectively, and data are reported as total hydrocarbons, methane and non-methane hydrocarbons. The summary of data for hydrocarbons that appears in Table 8, Appendix 5 shows no significant trend in levels of total hydrocarbons from 1972 to 1979.

OXIDANTS

Oxidants in the ambient air are primarily a result of a series of photochemical reactions and inter-reactions involving oxides of nitrogen and hydrocarbons. The reactions are promoted by certain meteorological conditions such as warm temperatures and intense sunshine, resulting in higher levels of oxidants in the spring and summer months.

Throughout 1979 the Ministry of the Environment measured oxidants in the form of ozone at station 14064 in the downtown core of Sarnia, and station 14118, situated in a rural setting approximately 10 kilometres east of Sarnia. Ozone was also monitored from February through mid-June 1979 at station 14901 located in Corunna. Ozone normally accounts for 80 to 95 percent of the oxidants present in ambient air. Consequently, with technology for monitoring ozone being more accurate and efficient than for total oxidants, most regulatory agencies monitor for ozone.

Long-range transport of ozone and its precursor chemicals (oxides of nitrogen and hydrocarbons) may account for a very significant portion of local levels of ozone. Long-range transport from distances greater than 200 kilometres has been reported in the literature. Therefore, successful control of oxidants will depend on control strategies implemented in the United States as well as in Ontario.

Ozone is also present in the stratosphere where it plays a critical role in absorbing excessive amounts of ultraviolet solar radiation that may be biologically harmful. Occasionally, ozone from the stratosphere may be transported downwards to create elevated concentrations at the earth's surface. Ozone is naturally produced in minor amounts by lightning.

The criterion for desirable ambient air quality established for ozone is 80 parts per billion (ppb) averaged for 1 hour. This criterion was established for the protection of vegetation, property and human health. Some effects that are detrimental to health and are associated with oxidants are eye irritation and a decrease in performance during athletic endeavors.

During 1979 the criterion was exceeded 130 times at station 14064 in the downtown core, 137 times at station 14118 in the rural area east of Sarnia, and 37 times during the 4½ months of monitoring at station 14901 in Corunna. Prior to July, 1978, ozone monitoring in the downtown core was conducted at station 14049 rather than station 14064. Station 14049 experienced higher levels of pollutants (other than ozone) than station 14064, whereas one might have anticipated lower frequencies of excursions for ozone at the former station because of greater scavenging of ozone by the other pollutants. A summary of ozone data is presented in Table 9, Appendix 5. Since the formation of oxidants is heavily dependent on meteorological conditions, fluctuations in the frequencies of excursions from year to year are to be expected.

Pollution roses for 1979 for ozone, which appear in Figure 7, Appendix 5, illustrate the percentage of the total number of excursions at each station that are associated with different wind directions. It is evident from the roses that the majority of excursions are associated with southerly and south-southwesterly winds. Southerly and south-southwesterly winds are apt to be associated with the backs of high pressure systems or the area south of low pressure fronts which have weather favourable for photochemical reactions (clear sunny skies and warmer temperatures) and which promote long range transport of oxidants and their precursor chemicals from the United States.

FLUORIDES

In the Sarnia area fluorides are emitted into the atmosphere from fossil-fueled power plants where it exists as an impurity in coal, from a fertilizer plant where it occurs as a constituent of phosphate rock, and from petroleum refineries where it is used as a catalyst in alkylation.

Fluoridation rate is a measurement designed to indicate relative amounts of gaseous fluoride present over an extended period of time. A lime-impregnated filter is exposed to ambient air for thirty days and subsequently analyzed for fluoride content. This technique is inexpensive compared to other methods for measuring airborne fluorides. Some fluorides in particulate form are collected on the filters.

Criteria for desirable ambient air quality established for fluoridation rate are based on protection of vegetation. A criterion of 40 micrograms of fluoride per 100 square centimetres of filter per 30 days (ugF/100 cm^2/30 days) exists for the growing season of April 15 to October 15 and a less stringent criterion of 80 ugF/100 cm^2/30 days exists for the period of October 16 to April 14. Since the months of April and October are common to both criteria and fluoridation rate is determined on a monthly basis, excursions above the criteria during these months are determined by comparing fluoridation rate to the average of the two criteria (60 ugF/100 cm^2/30 days).

The Ministry monitors fluoridation rate at station 14004, located south of Courtright in the vicinity of the fertilizer complex of Canadian Industries Limited and power plants of Ontario Hydro and Detroit Edison, and at station 14049 in downtown Sarnia. Canadian Industries Limited has maintained a detailed network of fluoridation candles for many years and also operates a continuous gaseous fluoride analyzer.

During 1979 the criterion for the growing season was exceeded at station 14004 for the 5 consecutive months of May through September, as was the case in 1978. The less stringent criterion for the non-growing season was not exceeded. At station 14049 the criterion for the growing

season was exceeded for 4 consecutive months during 1979 while the criterion for the non-growing season was not exceeded. Table 10, Appendix 6 presents data for fluoridation rate from 1972 to 1979.

Fluoridation rate serves to indicate if levels of fluorides exist that might cause vegetation damage. Annual phytotoxicology surveys have not revealed vegetation damage attributable to fluorides in Sarnia or outside of company property in the Courtright area.

APPENDIX I

MONITORING NETWORK

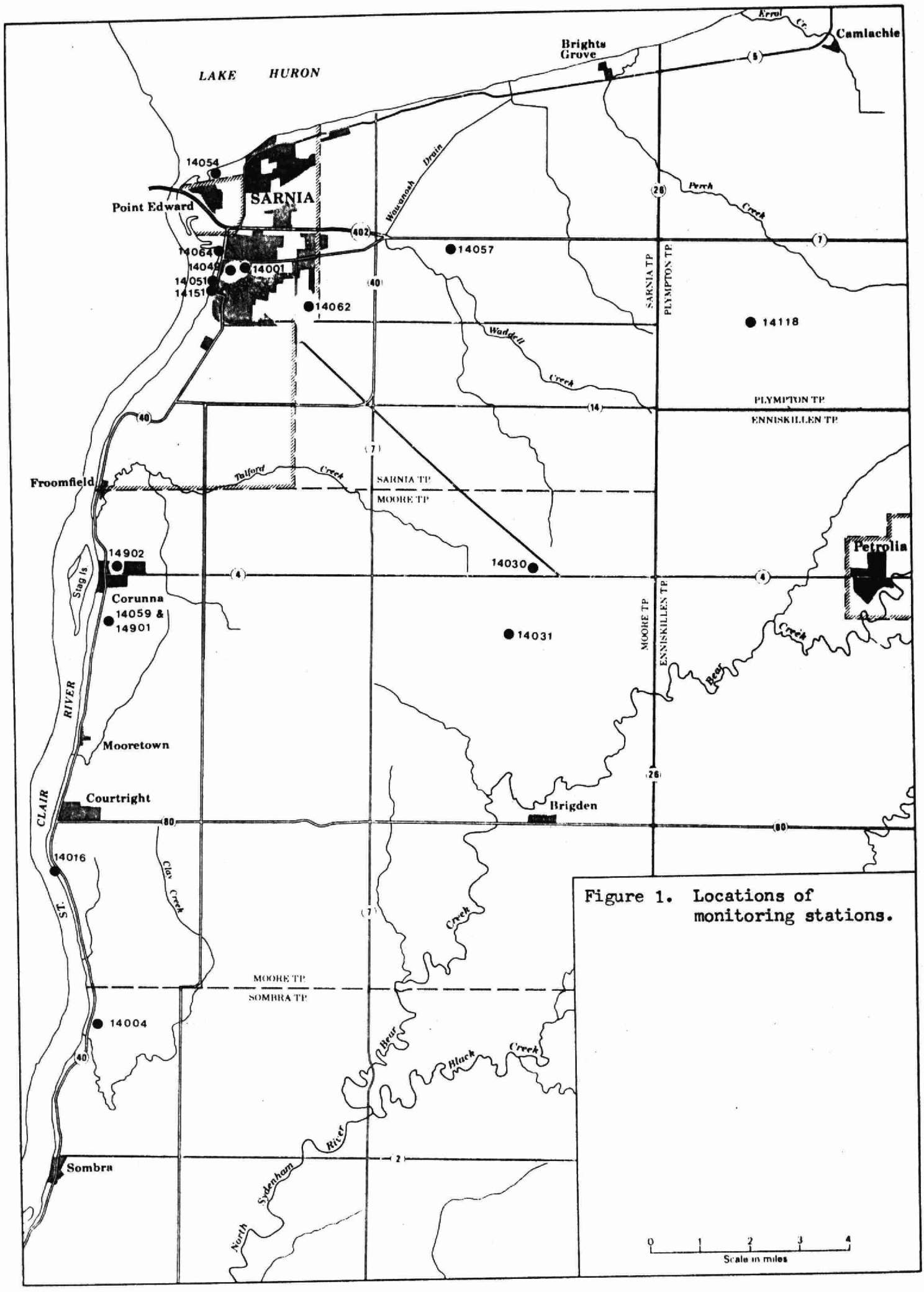


Figure 1. Locations of monitoring stations.

Table 1. Locations of monitoring stations and parameters being monitored.

Station No.	Location	Parameters measured	Height of measurements	Purpose of stations and comments
14001	Sarnia General Hospital	Suspended particulates	16 m.	Historical station which has been in operation since 1962. Does not reflect ground level concentrations but does indicate more direct effects of particulates from high stacks.
14004	5½ miles south of Courtright	Continuous SO_2 fluoridation rate	4 m.	Monitors SO_2 from power generating stations and fluorides from fertilizer industry.
14016	1¼ miles south of Courtright	Suspended particulates continuous SO_2, WS, WD, Temp., WS, WD, Temp., WS, WD, Temp., telemetering equipment	1 m. 10 m. 30 m. 92 m.	Monitors suspended particulates and sulphur dioxide in relation to power generating plants. Provides meteorological data required for stability forecasts and air quality interpretations.
14030	R. R. #1 Corunna	Suspended particulates	3 m.	Monitors particulates in the vicinity of of Tricil Limited.
14031	R. R. #1 Mooretown	Suspended particulates	3 m.	Monitors particulates in the vicinity of Tricil Limited.
14049	Victoria Street	Continuous SO_2, suspended particulates, dustfall, fluoridation rate	4 m.	Monitors air pollutants in a heavily populated area where the pollutants from traffic, commercial establishments and the heavily industrialized complex south of the monitoring station should be high relative to residential areas.
14051	Front and Lochiel Street,	Suspended particulates dustfall	3 m.	Monitors pollutants in commercial area which is also affected by heavily industrialized area to south. Since this is the location of a monitoring station operated by the Lambton Industrial Society, cross checking of monitoring techniques is possible.

Table 1. continued

Station No.	Location	Parameters measured	Height of measurements	Purpose of stations and comments
14054	Sarnia Yacht Club	Suspended particulates	5 m.	Monitors suspended particulates in the north Sarnia-Point Edward area.
14057	Briarwood Recreation Centre	Suspended particulates	10 m.	Monitors suspended particulates in Sarnia Township, northeast of the main industrial area.
14059	Riverbend, Corunna	Suspended particulates	4 m.	Monitors suspended particulates in the residential area of Corunna which is surrounded by industry and generating stations.
14062	Eastland Plaza, 242A Indian Rd. S.,	Continuous SO_2, H_2S & mercaptans WS, WD	6 m. 10 m.	Monitors SO_2, H_2S and mercaptans in residential-commercial area of east Sarnia which is adjacent to refinery operations. Provides meteorological data useful in identifying sources of pollutants.
14064	Centennial Park Front Street, Sarnia	Continuous SO_2, CO, NO, NO_2, NO_x, O_3, total hydrocarbons, 1-hr COH, suspended particulates, telemetering equipment	3 m.	Monitors main air pollutants in an area adjacent to downtown Sarnia and in line with many point sources of pollution located to the south of the downtown area. Provides Air Pollution Index for Sarnia.
14118	Petrolia Public Utilities Commission Pumping Station, 4 miles west of Wyoming.	O_3	5 m.	Monitors ozone levels in a rural location

Table 1. continued

Station No.	Location	Parameters measured	Height of measurements	Purpose of stations and comments
14151	Front and David Streets, downtown Sarnia	Suspended particulates dustfall	3 m.	Station was established in February, 1979 by relocating station 14051 300 m. south to alleviate effects from construction activities.
14901	St. Clair Blvd. & Hwy. 40B, Corunna	Continuous SO_2, NO, NO_2, NO_x, O_3, methane, total & non-methane hydrocarbons, suspended particulates,	3 m.	Main air pollutants monitored for several months in a residential area of south Corunna using instrumented van. This site is also the location of a main station of the Lambton Industrial Society.
		wind speed and direction	10 m.	
14902	Paget St., Corunna	Continuous SO_2, NO, NO_2, NO_x, O_3, methane, total & non-methane hydrocarbons, suspended particulates,	3 m.	Main air pollutants monitored in residential area of north Corunna using instrumented van for several months.
		wind speed and direction	10 m.	

Table 2. Desirable ambient air quality criteria established for Ontario

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Carbon monoxide	30 ppm averaged for 1 hour	Protection of human health
	13 ppm averaged for 8 hours	Protection of human health
Dustfall	7.0 g/metre^2 in 30 days	Historical and in keeping with other control agencies
	4.6 g/metre^2 (mean monthly average in 1 year)	
Fluoridation rate	40 ug F/100 cm^2 of limed filter paper in 30 days during April 15 to October 15.	Protection of vegetation
	80 ug F/100 cm^2 of limed filter paper in 30 days during October 16 to April 14.	Protection of vegetation (less restrictive criterion during the non growing season)
Hydrocarbons (total, methane & non-methane)	NONE	Effects of hydrocarbons vary widely depending on their chemical-physical nature. Certain non-methane hydrocarbons may react photochemically to produce oxidants.
Hydrogen sulphide	0.02 ppm averaged for 1 hour	Protection against offensive odours.
Mercaptans	0.01 ppm averaged for 1 hour	Protection against offensive odours.
Nitric oxide	NONE	Reacts with oxygen to produce NO_2.
Nitrogen dioxide	0.20 ppm averaged for 1 hour	Protection of human health and protection against offensive odours.
	0.10 ppm averaged for 24 hours	Protection of human health and protection against offensive odours.

Table 2. continued

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Nitrogen oxides	NONE	
Ozone	0.08 ppm averaged for 1 hour	Protection of vegetation, adverse health effects
Sulphur dioxide	0.25 ppm averaged for 1 hour	Protection of vegetation
	0.10 ppm averaged for 1 day (24 hours)	Protection of human health
	0.02 ppm averaged for 1 year	Protection of vegetation
Suspended particulates	120 ug/m³ averaged for 24 hours	Based on health effects in conjunction with elevated levels of SO_2 and impairment of visibility.
	A geometric mean of 60 ug/m³ during 1 year	Based on public awareness of visible pollution
Cadmium in suspended particulates	2.0 ug/m³ averaged for 24 hours	Protection of human health
Lead in suspended particulates	5 ug/m³ averaged for 24 hours	Protection of human health
	A geometric mean of 2 ug/m³ over a 30-day period	Protection of human health
Nickel in suspended particulates	2.0 ug/m³ averaged for 24 hours	Protection of vegetation
Vanadium in suspended particulates	2.0 ug/m³ averaged for 24 hours	Protection of human health

APPENDIX 2

METEOROLOGICAL DATA

Table 3. Percent frequencies of wind directions at the 30-metre level of station 14016.

Year	N	NE	E	SE	S	SW	W	NW
1979	10.7	8.7	6.5	8.9	24.7	14.7	11.9	14.0
1978	13.6	12.7	6.3	6.0	19.0	17.2	11.9	13.3
1977	11.3	9.8	5.3	7.2	18.5	21.2	14.1	12.6
1976	12.2	9.2	3.5	4.7	18.1	20.5	15.1	16.7
1975	9.4	11.6	6.7	7.6	19.3	20.5	12.9	12.1
1974	12.2	10.6	5.2	5.7	20.6	21.6	12.1	12.1
1973	11.6	11.0	8.1	7.2	15.8	20.6	12.9	12.8
1972	15.8	12.0	6.5	8.3	17.4	16.4	11.7	12.0

APPENDIX 3

PARTICULATES

Table 4. Summary of 1979 data for total suspended particulates

Station Number	No. of samples collected	Annual geometric mean (ug/m³)	No. of values greater than 24-hour criterion	Percentage of values greater than 24-hour criterion
14001	54	44	0	0
14016	56	49	3	5
14030	55	38	0	0
14031	58	38	3	5
14049	56	71	8	14
14054	54	52	4	7
14057	57	40	0	0
14059	57	43	0	0
14064	57	66	6	11
14151	53	74	14	26

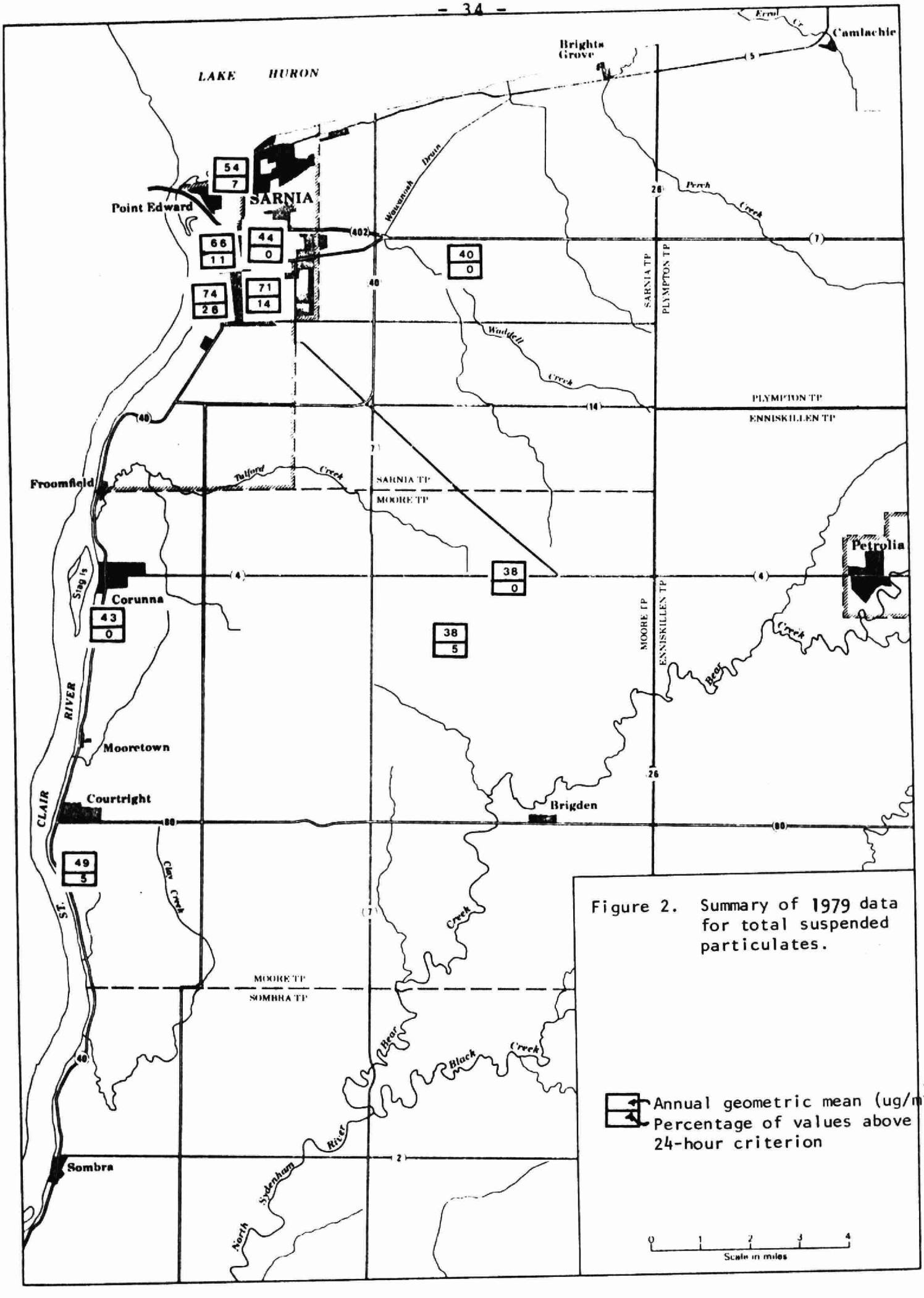
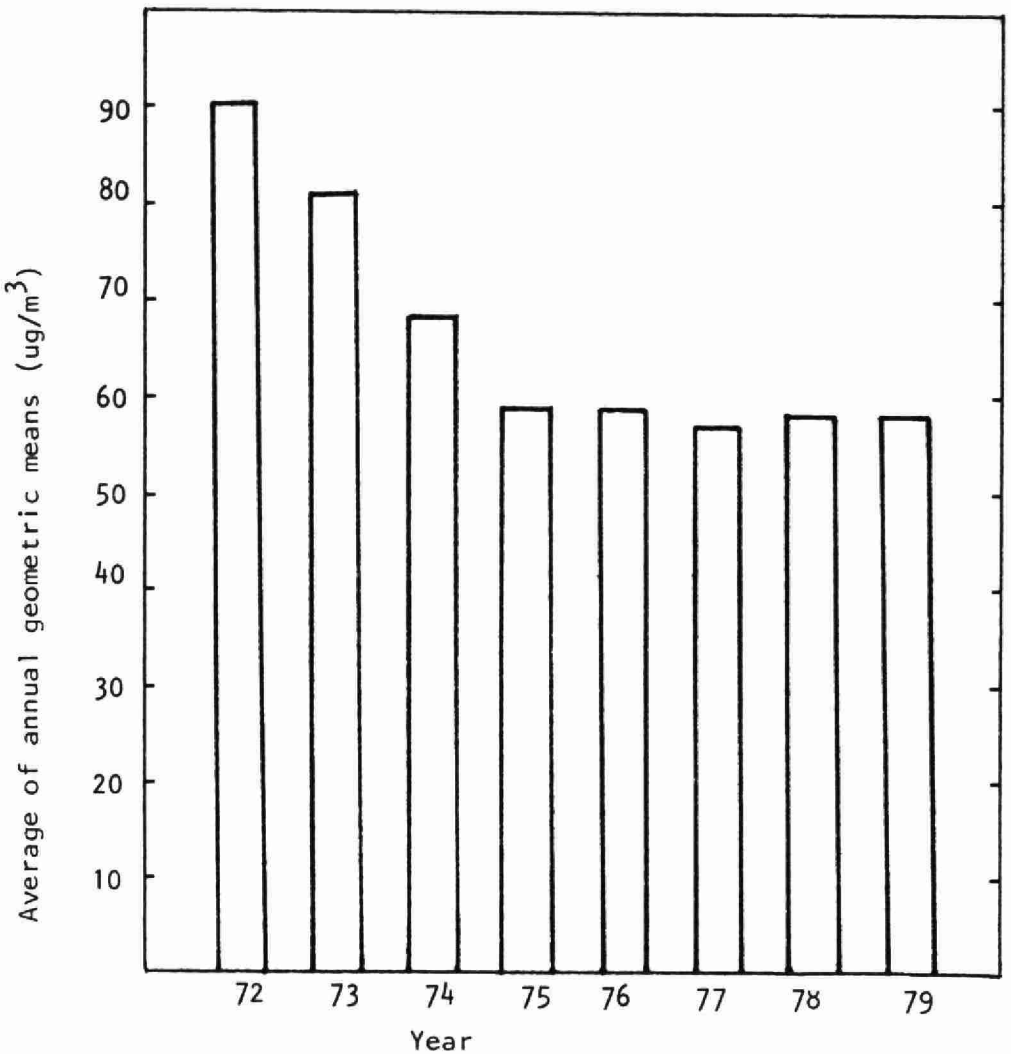
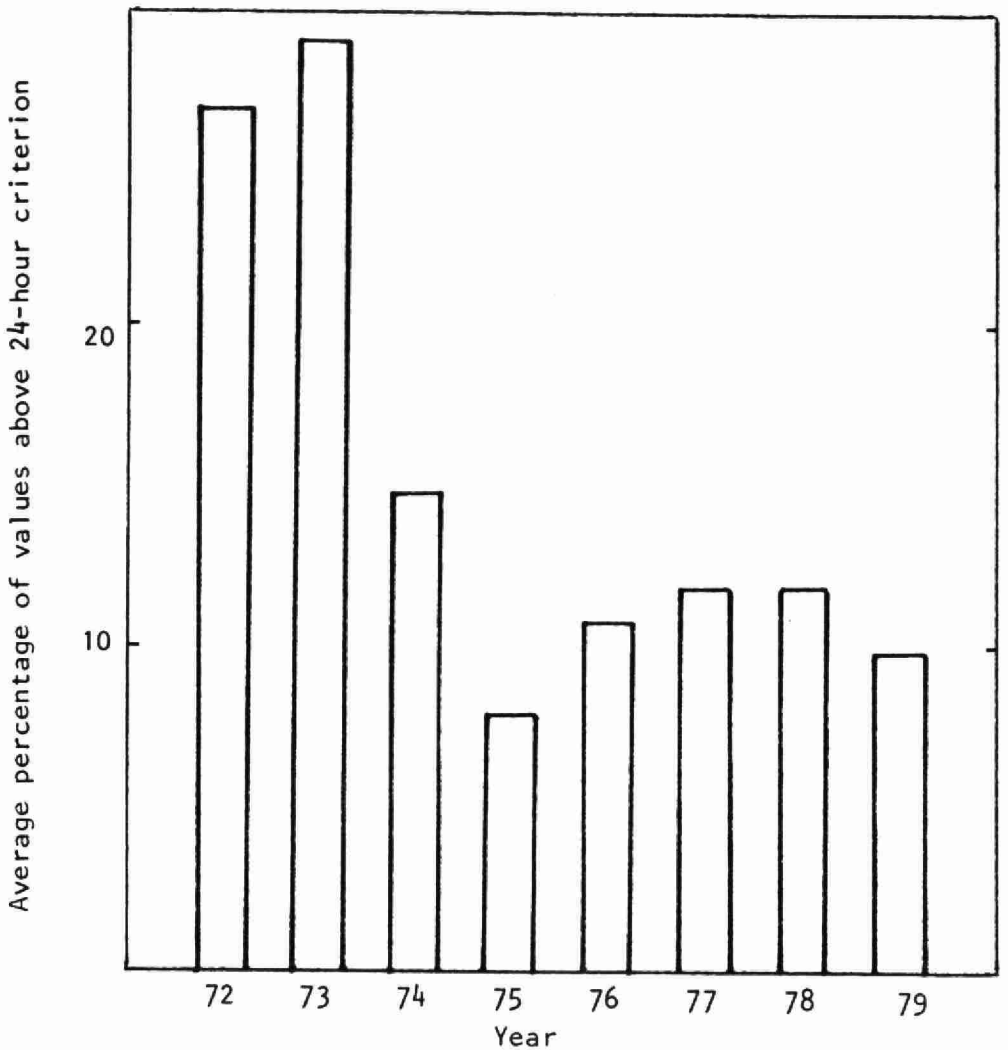


Figure 2. Summary of 1979 data for total suspended particulates.

Figure 3. Trend in levels of total suspended particulates based on data averaged for five monitoring stations from 1972 to 1979





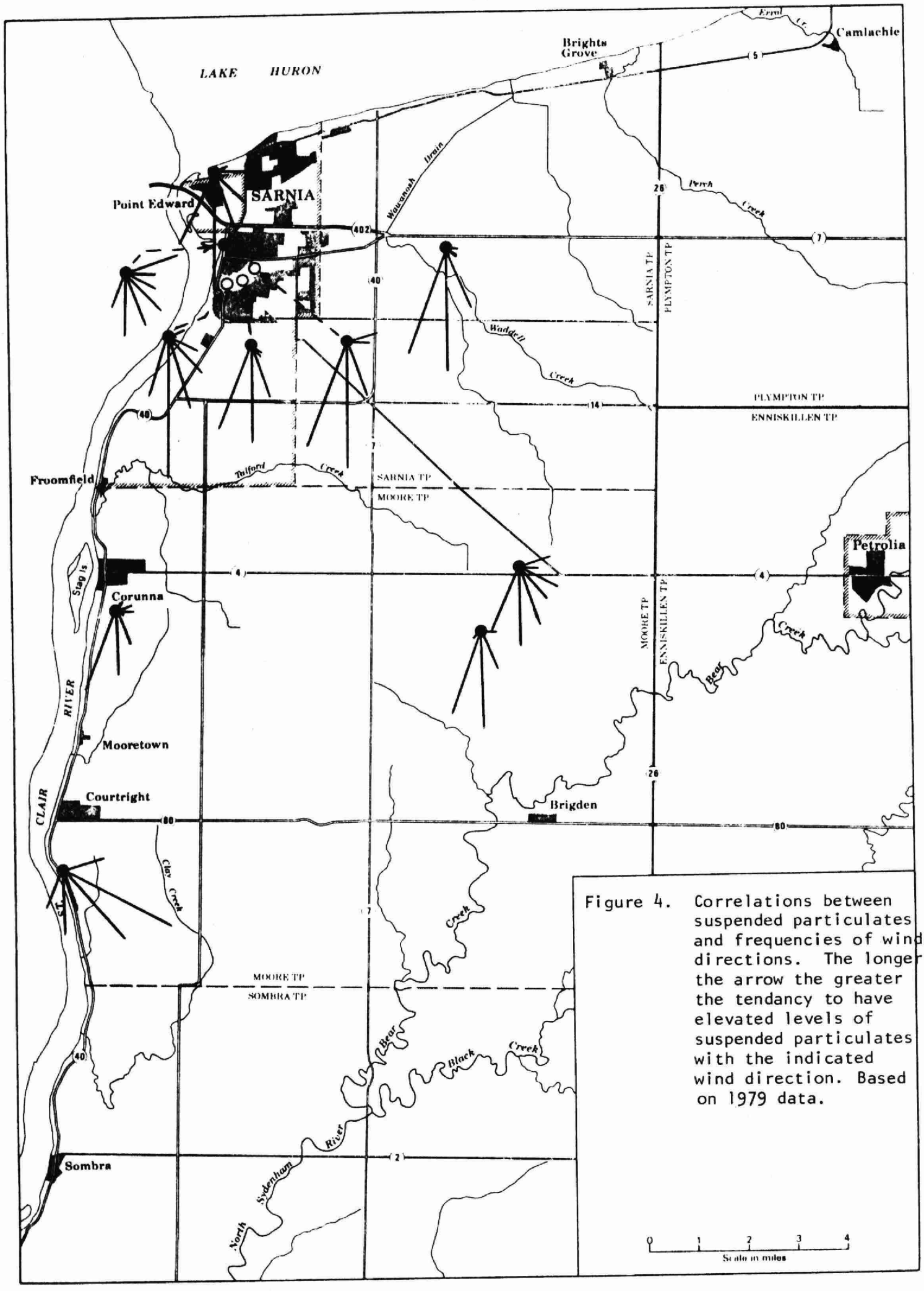


Figure 4. Correlations between suspended particulates and frequencies of wind directions. The longer the arrow the greater the tendancy to have elevated levels of suspended particulates with the indicated wind direction. Based on 1979 data.

Table 5. Concentrations (ug/m³) of various constituents of suspended particulates: 1976 to 1979.

Station and Year	Cadmium # of samples	Cadmium Avg.	Cadmium Max.	Chromium # of samples	Chromium Avg.	Chromium Max	Copper # of samples	Copper Avg.	Copper Max	Iron # of samples	Iron Avg.	Iron Max	Lead # of samples	Lead Avg.	Lead Max
14001															
1976	10	0.001	0.004	10	0.017	0.066	10	0.31	0.73	10	1.0	2.4	10	0.3	0.6
1977	18	0.000	0.003	18	0.009	0.030	18	0.68	2.48	18	1.2	5.8	18	0.3	1.3
1978	24	0.001	0.005	24	0.010	0.023	24	0.22	0.54	24	1.1	4.0	24	0.2	0.7
1979	32	0.001	0.003	32	0.003	0.013	32	0.23	0.62	32	0.8	3.0	32	0.2	0.4
14016															
1976	18	0.000	0.003	18	0.003	0.011	18	0.41	1.17	18	0.6	1.6	18	0.2	0.4
1977	21	0.000	0.002	21	0.008	0.025	21	0.31	0.58	21	0.6	1.8	21	0.2	0.6
1978	26	0.001	0.003	26	0.007	0.019	26	0.50	1.38	26	0.9	3.2	26	0.1	0.4
1979	35	0.001	0.004	35	0.002	0.010	35	0.39	1.01	35	0.8	2.9	35	0.2	0.6
14030															
1978	11	0.002	0.004	11	0.007	0.019	11	0.37	0.98	11	1.2	2.2	11	0.3	0.9
1979	50	0.001	0.004	50	0.007	0.022	50	0.32	1.36	55	0.6	2.2	54	0.1	0.4
14031															
1978	12	0.002	0.003	12	0.004	0.008	12	0.44	1.00	12	0.7	1.3	12	0.1	0.3
1979	54	0.001	0.005	54	0.010	0.189	54	0.25	0.97	58	0.5	2.7	54	0.1	0.4
14051 (14151)															
1976	17	0.001	0.003	18	0.032	0.157	17	0.08	0.15	17	1.0	3.4	17	0.3	0.8
1977	20	0.000	0.003	20	0.007	0.021	20	0.10	0.28	20	0.6	1.3	20	0.2	0.5
1978	21	0.001	0.005	21	0.006	0.016	21	0.09	0.40	21	1.0	3.1	21	0.3	0.9
1979	30	0.001	0.007	30	0.004	0.016	30	0.05	0.27	30	1.5	4.9	30	0.3	0.7
14054															
1976	3	0.002	0.004	3	0.000	0.000	3	0.17	0.18	3	0.5	0.7	3	0.2	0.3
1977	15	0.001	0.003	15	0.003	0.010	15	0.46	2.16	15	0.7	1.9	15	0.2	0.5
1978	24	0.001	0.008	24	0.008	0.019	24	0.31	0.73	24	0.9	1.9	57	0.2	1.3
1979	34	0.002	0.007	34	0.004	0.013	34	0.35	0.75	34	0.9	2.7	55	0.2	1.1
14049															
1976													70	0.5	1.5
1977													50	0.6	1.3
1978													50	0.5	1.7
1979													56	0.3	1.3

Table 5. continued

Station and Year	Manganese # of samples	Manganese Avg.	Manganese Max.	Nickel # of samples	Nickel Avg.	Nickel Max	Nitrate # of samples	Nitrate Avg.	Nitrate Max	Sulphate # of samples	Sulphate Avg.	Sulphate Max	Vanadium # of samples	Vanadium Avg.	Vanadium Max
14001															
1976	2	0.30	0.37	10	0.029	0.107	58	3.8	15.8	58	8.6	44.6	10	0.02	0.11
1977	18	0.04	0.23	18	0.014	0.064	47	4.7	24.5	48	12.9	43.9	18	0.01	0.07
1978	24	0.08	0.58	24	0.010	0.033	51	4.6	21.3	51	11.1	39.7	24	0.00	0.02
1979	32	0.06	0.38	32	0.010	0.076	54	4.8	16.0	54	11.0	35.7	32	0.01	0.07
14016															
1976	8	0.01	0.04	18	0.013	0.031	96	4.0	20.0	105	8.7	33.4	18	0.00	0.02
1977	21	0.03	0.09	21	0.022	0.165	54	3.7	27.8	54	10.0	24.6	21	0.01	0.08
1978	26	0.02	0.06	26	0.016	0.194	53	4.6	24.6	53	11.2	35.3	26	0.00	0.10
1979	35	0.02	0.07	35	0.008	0.042	56	5.4	14.8	56	12.4	41.0	35	0.00	0.01
14030															
1978				11	0.009	0.013									
1979	45	0.01	0.05	50	0.006	0.032							45	0.00	0.02
14031															
1978				12	0.016	0.057									
1979	46	0.02	0.07	54	0.009	0.171							46	0.00	0.01
14051 (14151)															
1976	17	0.03	0.07	17	0.023	0.084	59	3.7	11.7	58	9.3	45.1	17	0.03	0.12
1977	20	0.03	0.06	20	0.009	0.022	56	3.9	22.4	56	10.9	32.1	20	0.00	0.02
1978	21	0.06	0.18	21	0.012	0.047	59	5.4	19.2	59	12.8	47.1	21	0.01	0.12
1979	30	0.06	0.33	30	0.018	0.077	44	6.1	25.4	44	13.5	42.2	30	0.02	0.10
14054															
1976	3	0.02	0.04	3	0.023	0.063	54	3.7	13.2	61	8.9	34.8	3	0.02	0.03
1977	15	0.03	0.10	15	0.009	0.021	49	3.8	20.2	49	10.1	25.7	15	0.01	0.03
1978	24	0.04	0.12	24	0.005	0.024	49	4.8	20.4	49	11.5	37.0	24	0.00	0.04
1979	34	0.03	0.11	34	0.011	0.059	55	5.1	14.3	55	12.5	39.2	34	0.01	0.06

Table 6. Values for dustfall (g/m²/30 days) in downtown Sarnia

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Arithmetic Mean
Station 14049													
1972		7.4	7.7	7.0	2.1		2.5	3.2	2.1	4.2		3.2	4.4
1973	5.3	3.5	10.5	4.6	7.7	4.6	3.9	2.8	3.5	6.0	8.8	3.5	5.4
1974	3.5	4.6	9.8	5.6	5.6	6.0	4.2	2.5	3.2	3.5	4.2	3.9	4.7
1975	4.2	4.2	6.0	6.0	6.0	4.6	3.2	6.7	4.2	5.6	3.9	2.8	4.8
1976	2.8	6.0	8.1	6.7	5.6	4.9	4.9	3.2	3.5	4.6	4.3	4.2	4.9
1977	1.6	5.9	8.7	5.4	5.0	5.5	2.6	3.0	4.4	3.3	5.6	5.5	4.7
1978	1.1	2.0	9.1	7.1	3.0	5.5	4.1	2.9	4.5	2.0	3.7	6.4	4.3
1979	2.7	5.1	5.7	13.3	8.3	5.3	4.7	3.4	4.6	3.7	4.9	2.6	5.4
Station 14051 (14151)													
1972				7.4			2.1	6.7	4.9	3.9		3.2	4.7
1973	3.5	2.5	6.3	5.6	6.3	6.3	1.8	2.5	2.8	4.9	5.6	2.8	4.2
1974	3.2	4.9	7.0	7.0	5.6	7.0	4.9	2.8	4.2	4.6	3.2	4.2	4.9
1975	4.6	2.1	4.2	2.1	5.6	5.2	4.2	9.1	3.5	5.6	4.2	2.1	4.4
1976	3.2	4.9	6.7	5.3	4.9	4.6	3.5	3.2	2.8	3.2	2.8	2.8	4.0
1977	0.9	3.9	5.6	5.5	4.9	5.2	4.6	4.0	5.1	3.1	4.4	4.4	4.3
1978	1.5	0.9	19.7	12.7	6.3	5.4	4.8	4.3	7.2	4.7	4.6	3.7	6.3
1979			4.6	6.2		4.3	4.9	2.0	3.0	3.1	3.5		4.0

Underlined values exceed either the criterion of 7.0 g/m²/30 days or the annual criterion of an average of 4.6 g/m²/30 days.

Station 14051 was replaced with station 14151 in February 1979.

APPENDIX 4

SULPHUR OXIDES

Table 7. Summary of 1979 data for sulphur dioxide

Station number	Annual average (ppm)	Percentage of values above criterion: 1-hr	24-hr	Maximum 1-hour value (ppm)	Maximum 24-hour (daily) value (ppm)
14004	0.01	0.01	0	0.26	0.08
14016	0.02	0.06	0.3	0.53	0.12
14049	0.02	0.03	1.1	0.31	0.12
14062	0.01	0	0	0.24	0.07
14064	0.02	0.06	0.3	0.32	0.13
14901	(a)	0.11	0.5	0.33	0.12
14902	(a)	0.07	0	0.28	0.04

(a) Insufficient data to calculate representative annual average. Station 14901 operated for 51% of year, station 14902 for 15% of year.

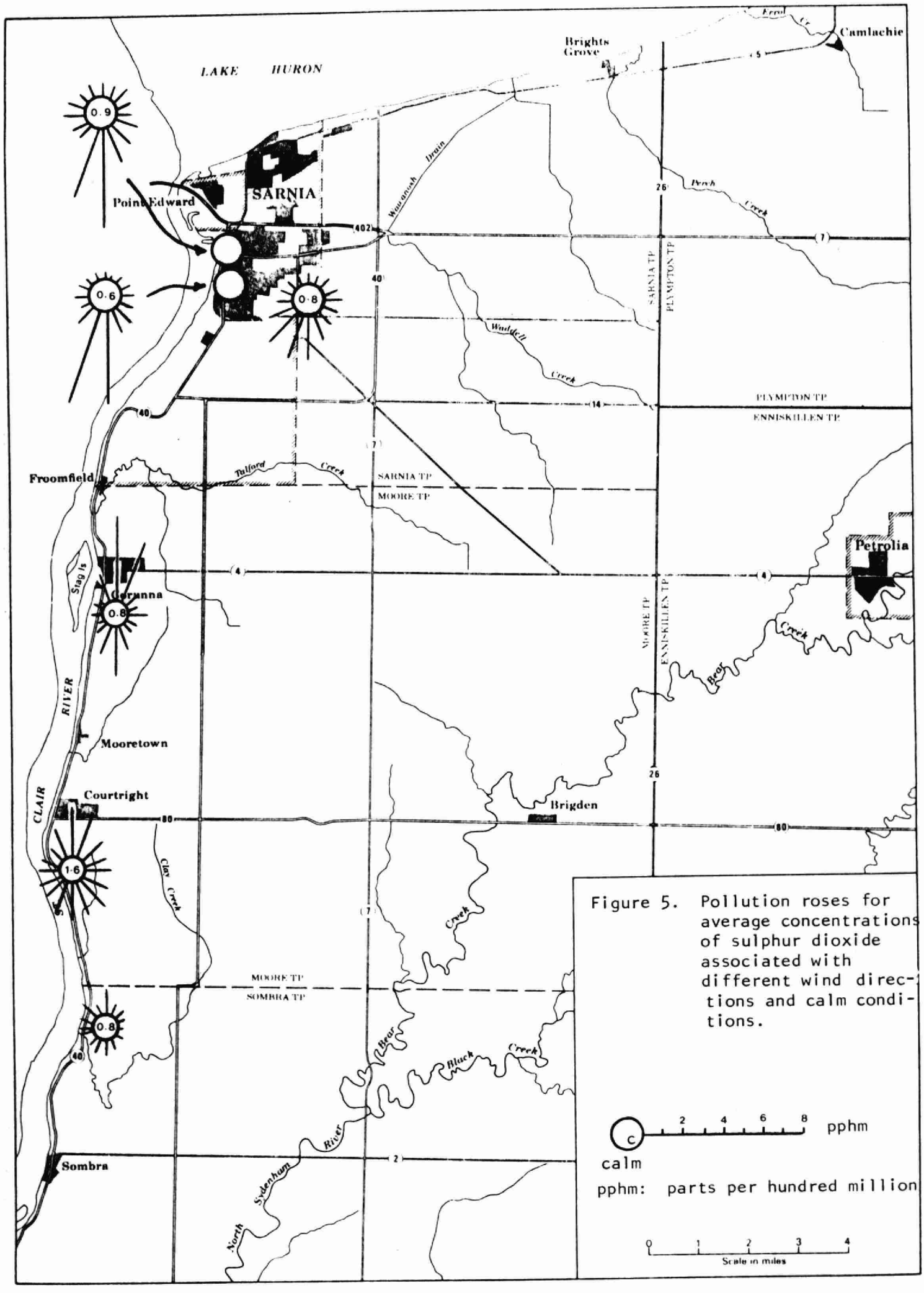
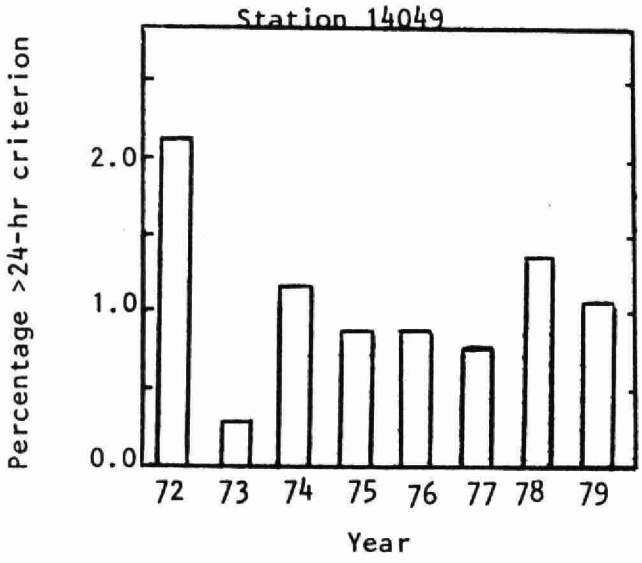
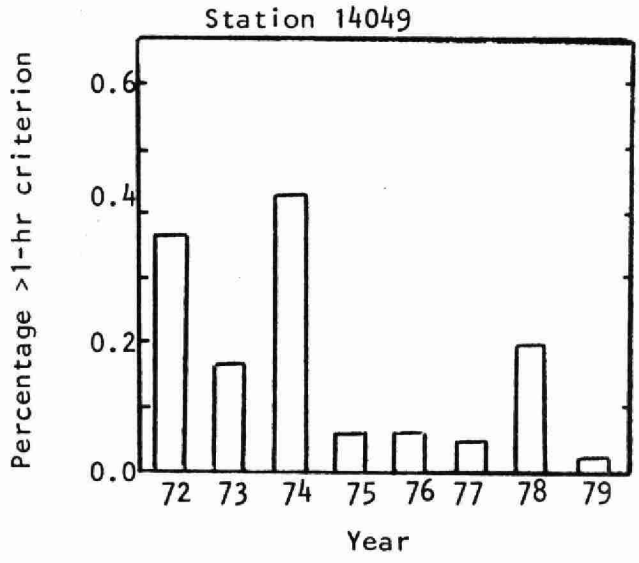
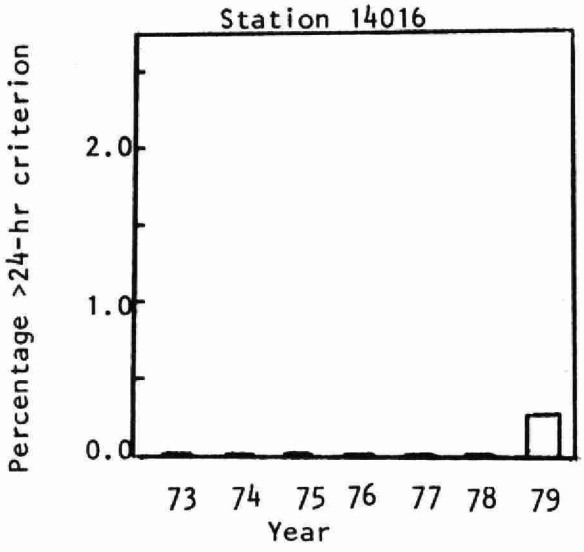


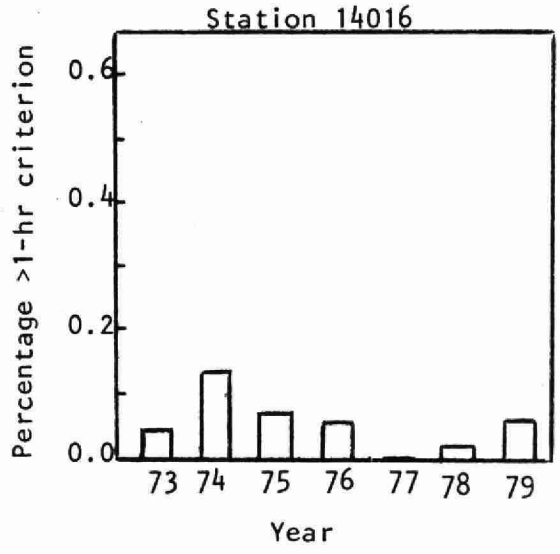
Figure 5. Pollution roses for average concentrations of sulphur dioxide associated with different wind directions and calm conditions.

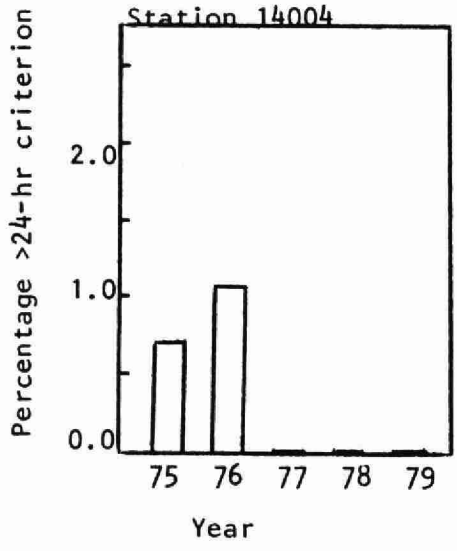
Figure 6. Trend in frequencies of excursions above 1-hour and 24-hour criteria for sulphur dioxide.

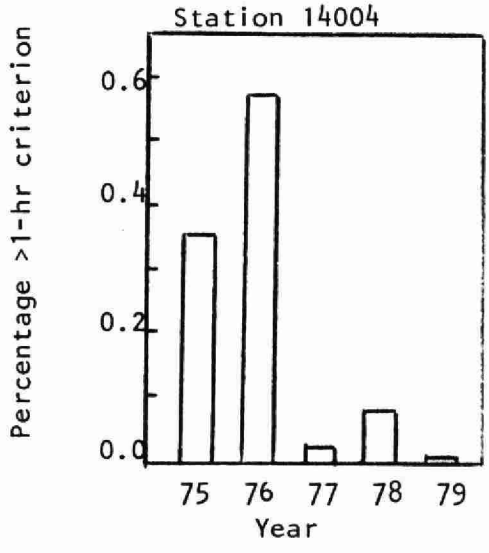












APPENDIX 5

HYDROGEN SULPHIDE AND MERCAPTANS, CARBON MONOXIDE, OXIDES OF NITROGEN, HYDROCARBONS AND OZONE

Table 8. Summary of data for hydrogen sulphide and mercaptans, carbon monoxide, oxides of nitrogen and hydrocarbons.

Pollutant and Criteria	Station number	Year					
		1979	1978	1977	1976	1975	1974
Hydrogen sulphide and mercaptans							
Annual average (ppm)	14062	0.001	0.001				
	14049		0.001	0.001	0.001	0.001	0.007
Percentage of values above 1-hr criterion[a]	14062	0.01	0.00				
	14049		0.15	0.01	0.04	0.38	9.78
Carbon Monoxide							
Annual average (ppm)	14064	0	0				
	14049		1	2	1	1	1
Percentage of values above: 1-hr criterion	14064	0	0				
	14049		0	0	0	0	0
8-hr criterion	14064	0	0				
	14049		0	0	0	0	0
Nitric oxide							
Annual average (ppm)	14064	0.02	0.02				
	14049		0.02	0.02	0.02		
	14901	0.00[b]					
	14902	0.01[b]					
Nitrogen dioxide							
Annual average (ppm)	14064	0.02	0.02				
	14049		0.03	0.03	0.03	0.02	
	14901	0.01[b]					
	14902	0.01[b]					

Table 8. continued

Pollutant and Criteria	Station number	Year					
		1979	1978	1977	1976	1975	1974
Percentage of values above:							
1-hr criterion	14064	0	0				
	14049		0	0	0	0	
	14901	0					
	14902	0					
24-hr criterion	14064	0	0				
	14049		0	0	0	0	
	14901	0					
	14902	0					
Total oxides of nitrogen							
Annual average (ppm)	14064	0.04	0.03				
	14049		0.05	0.05	0.05	0.05	
	14901	0.01 (b)					
	14902	0.02 (b)					
Total hydrocarbons							
Annual average (ppm)	14064	2.0	1.7				
	14049		2.6	2.4	2.3	2.6	2.8
	14901	2.0 (b)					
	14902	2.2 (b)					
Methane							
Annual average (ppm)	14901	1.6 (b)					
	14902	1.8 (b)					
Non-methane hydrocarbons							
Annual average (ppm)	14901	0.4 (b)					
	14902	0.3 (b)					

Note: (a) Criterion for hydrogen sulphide
(b) Annual average based on less than full year of data

Table 9. Summary of data for ozone

Station and Parmaeter	Year 1979	1978	1977	1976	1975	1974
Station 14049						
Annual average (ppm)		0.023	0.020	0.019	0.024	0.018
Number of values above 1-hr criterion		51	87	56	132	80
Percentage of values above 1-hr criterion		1.1	1.0	0.7	1.9	1.1
Station 14064						
Annual average (ppm)	0.023	0.018				
Number of values above 1-hr criterion	130	56				
Percentage of values above 1-hr criterion	1.6	1.4				
Station 14118						
Annual average (ppm)	0.027	0.029	0.027			
Number of values above 1-hr criterion	137	249	182			
Percentage of values above 1-hr criterion	1.7	3.5	2.6			
Station 14901						
Annual average (ppm)	0.029[(a)]					
Number of values above 1-hr criterion	37					
Percentage of values above 1-hr criterion	1.3					

(a) Data not representative of full year - instrument operated from February to mid-June 1979.

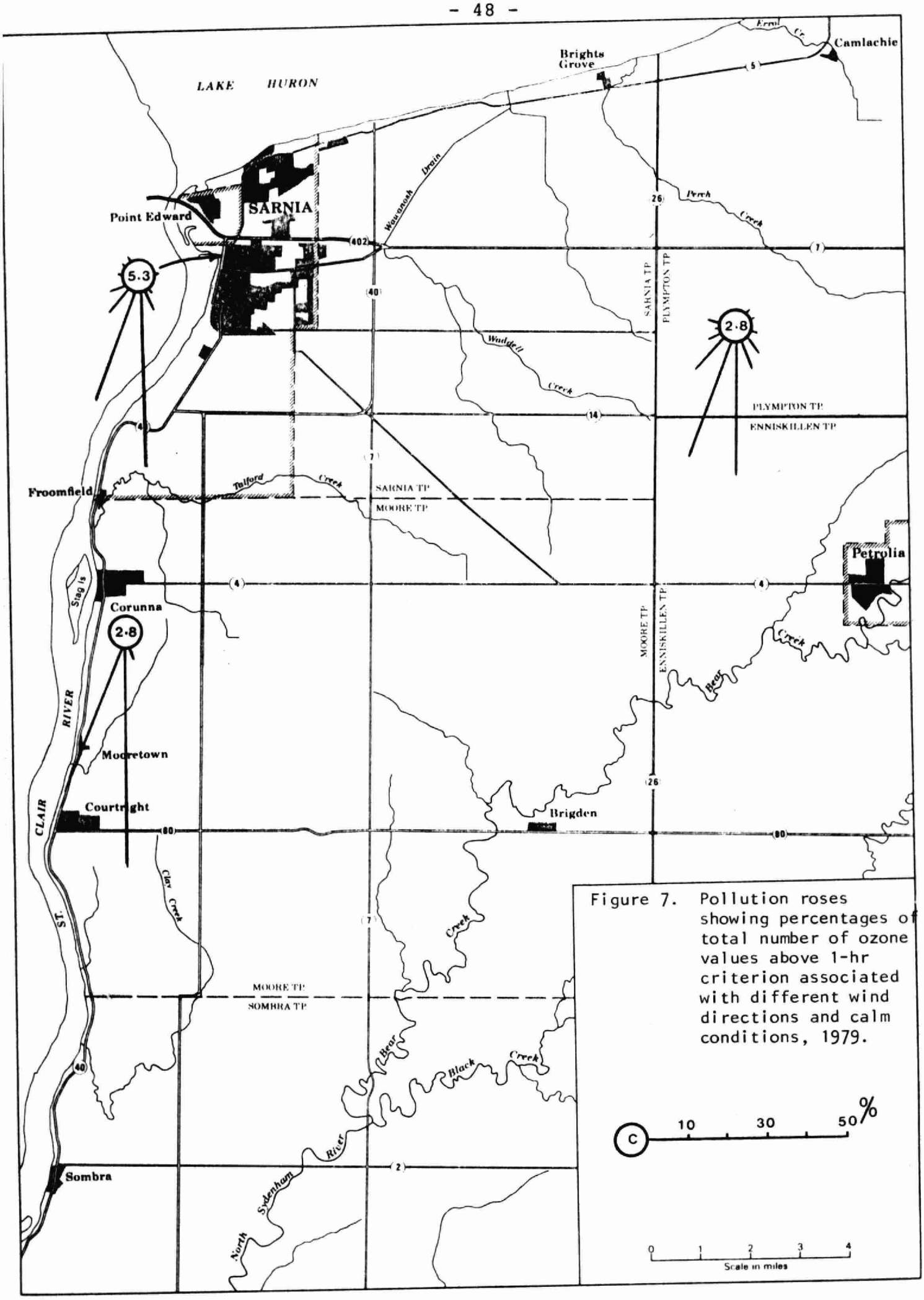


Figure 7. Pollution roses showing percentages of total number of ozone values above 1-hr criterion associated with different wind directions and calm conditions, 1979.

APPENDIX 6

FLUORIDES

Table 10. Fluoridation rates from 1972 to 1979 (ug F/100 cm^2/30 days)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Station 14049													
1972	85	60	22	32	28	56	29	80	20	23	17	45	41
1973	55	50	60	65	65	100	75	60	40	70	55	55	63
1974	67	56	44	66	18		48		50	44	66	80	54
1975	31	39	19	18		29	34	34	22	74	44	31	34
1976	37	53	36	11	18	24	6	42	32	27	29	31	29
1977	55	40	32	16	34	14	43	32	26	46	43	74	38
1978	72	47	38	22	29	39	43	49	45	30	97	55	47
1979	60	60	27	20	34	51	49	43	90	40	41	50	47
Station 14004													
1976						46	38	74	48	39	21	40	44
1977	42	23	53	32	78	31		79	112	29	104	50	58
1978	83	51	53	57	100	65	94	74	74	57	53	59	68
1979	32	63	25	56	54	64	68	129	89	49	32	26	57

NOTE: Underlined values exceeded criteria for desirable ambient air.

TERMINAL STREAM: CREDIT R.

DATE	ISSUED TO
	Martin